A COMPARISON BETWEEN LENSING AND X-RAY MASSES IN SIMULATED CLUSTERS

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INAF-OSSERVATORIO ASTRONOMICO DI BOLOGNA

IN COLLABORATION WITH:

ELENA RASIA (MICHIGAN)

STEFANO ETTORI (BOLOGNA)

FABIO BELLAGAMBA (BOLOGNA)

PASQUALE MAZZOTTA (ROME)

KLAUS DOLAG (MPA-GARCHING)

MOTIVATION

- [ ] MEASURING THE MASS OF GALAXY CLUSTERS IS IMPORTANT IF WE WANT TO USE THESE OBJECTS AS COSMOLOGICAL PROBES

- [ ] LENSING AND X-RAY ARE POTENTIALLY POWERFUL METHODS FOR CONSTRAINING THE MASS CONTENT OF CLUSTERS

- [ ] HOWEVER, THEY FREQUENTLY GIVE INCONSISTENT RESULTS...

OUR APPROACH

WE PROPOSE THE FOLLOWING EXPERIMENT:

- ☐ CREATE MOCK OBSERVATIONS IN THE OPTICAL AND IN THE X-RAY BANDS OF FEW SIMULATED GALAXY CLUSTERS (RELAXED AND UN-RELAXED)

- ☐ ANALYZE THESE DATA AS IF THEY WERE REAL DATA: STANDARD TECHNIQUES TO EXTRACT THE SIGNAL, TO TREAT THE NOISES, ETC.

- ☐ COMPARE THE RECOVERED MASS DISTRIBUTIONS TO THE INPUT MODELS

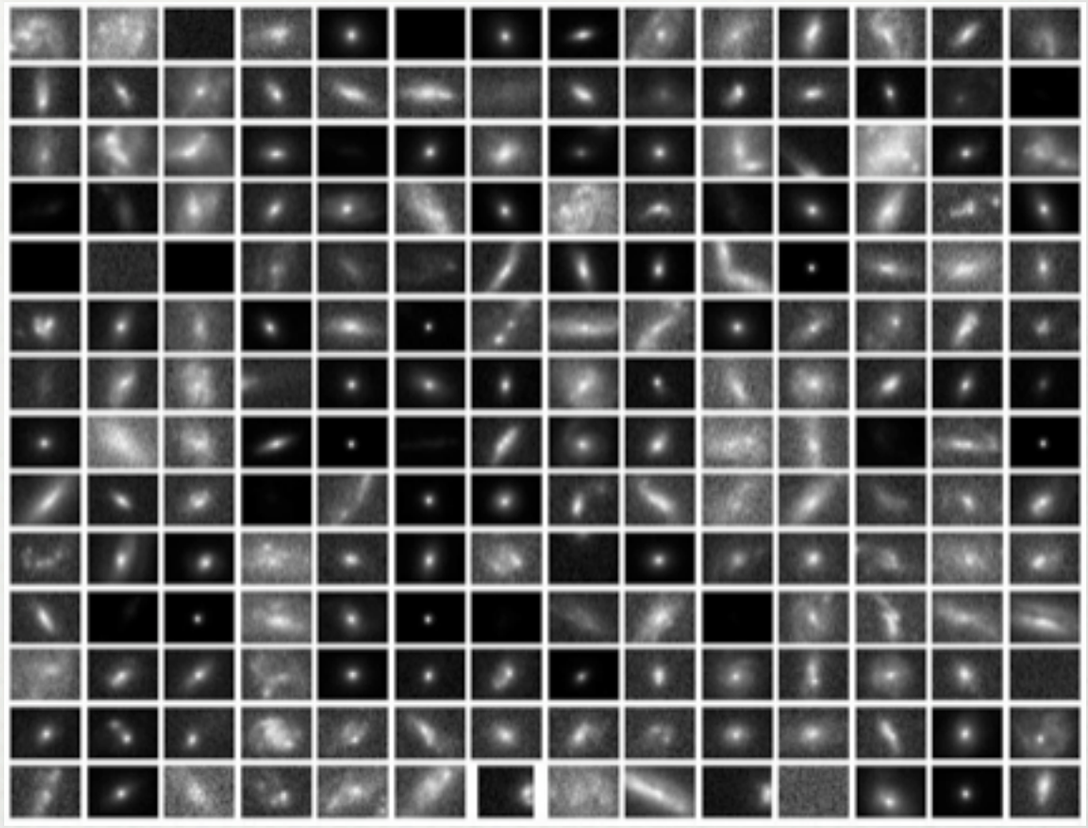
XMAS2

- [ ] SEE TALK BY E. RASIA

SKYLENS

MENEGHETTI ET AL. 2008

- ☐ USES REAL GALAXIES TAKEN FROM THE GOODS HST ARCHIVE + COMBO 17 DATA
- ☐ DECOMPOSED USING SHAPELETS
- ☐ SOURCE GALAXIES DRAWN FROM REALISTIC REDSHIFT AND LUMINOSITY DISTRIBUTIONS (VVDS)
- ☐ APPLY LENSING
- ☐ COMBINE SEVERAL GALAXIES TO SIMULATE PATCHES OF THE SKY
- ☐ OBSERVATIONS WITH DIFFERENT INSTRUMENTS AND ATMOSPHERIC CONDITIONS



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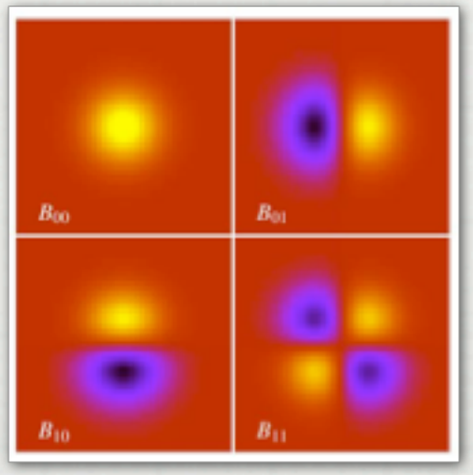
$$I(\vec{x}) = \sum_{n_1,n_2=0}^{\infty} I_{\vec{n}} B_{\vec{n}}(\vec{x} - \vec{x}_c, \beta)$$

$$I_{\vec{n}} = \int d^2x I(\vec{x}) B_{\vec{n}}(\vec{x}, \beta)$$



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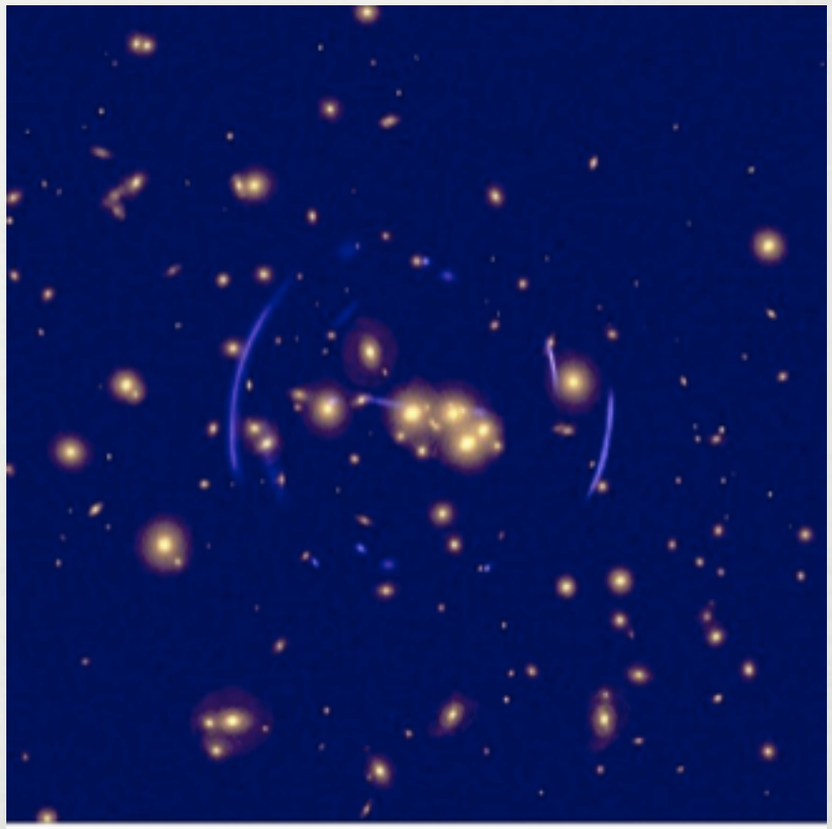
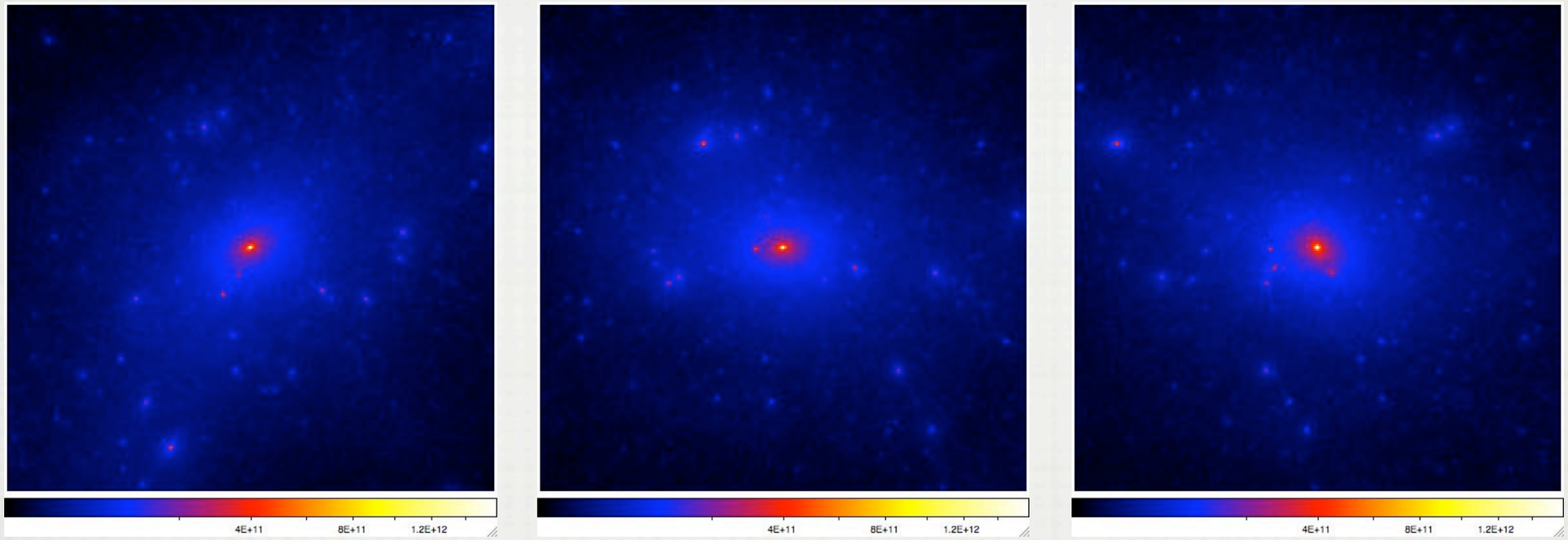


SIMULATED CLUSTERS



- SAMPLE OF CLUSTERS RE-SIMULATED AT HIGH RESOLUTION WITH COOLING, STAR FORMATION, SN FEEDBACK, THERMAL CONDUCTION. THIS TALK: ONE CLUSTER SEEN IN THREE PROJECTIONS.

- N. OF PARTICLES: BETWEEN FEW MILLIONS TO UP TO 15 MILLIONS WITHIN THE VIRIAL REGION

EXAMPLE: LENSING ANALYSIS

- ☐ IDENTIFICATION OF CLUSTER GALAXIES
- ☐ WEAK LENSING: KSB, MEASURE SHEAR FROM GAL. ELLIPT.
- ☐ STRONG LENSING: IDENTIFICATION OF MULTIPLE IMAGES
- ☐ FIT WITH LENSTOOL (KNEIB ET AL. 1993)
- ☐ DEPROJECTION ASSUMING SPHERICAL SYMM.

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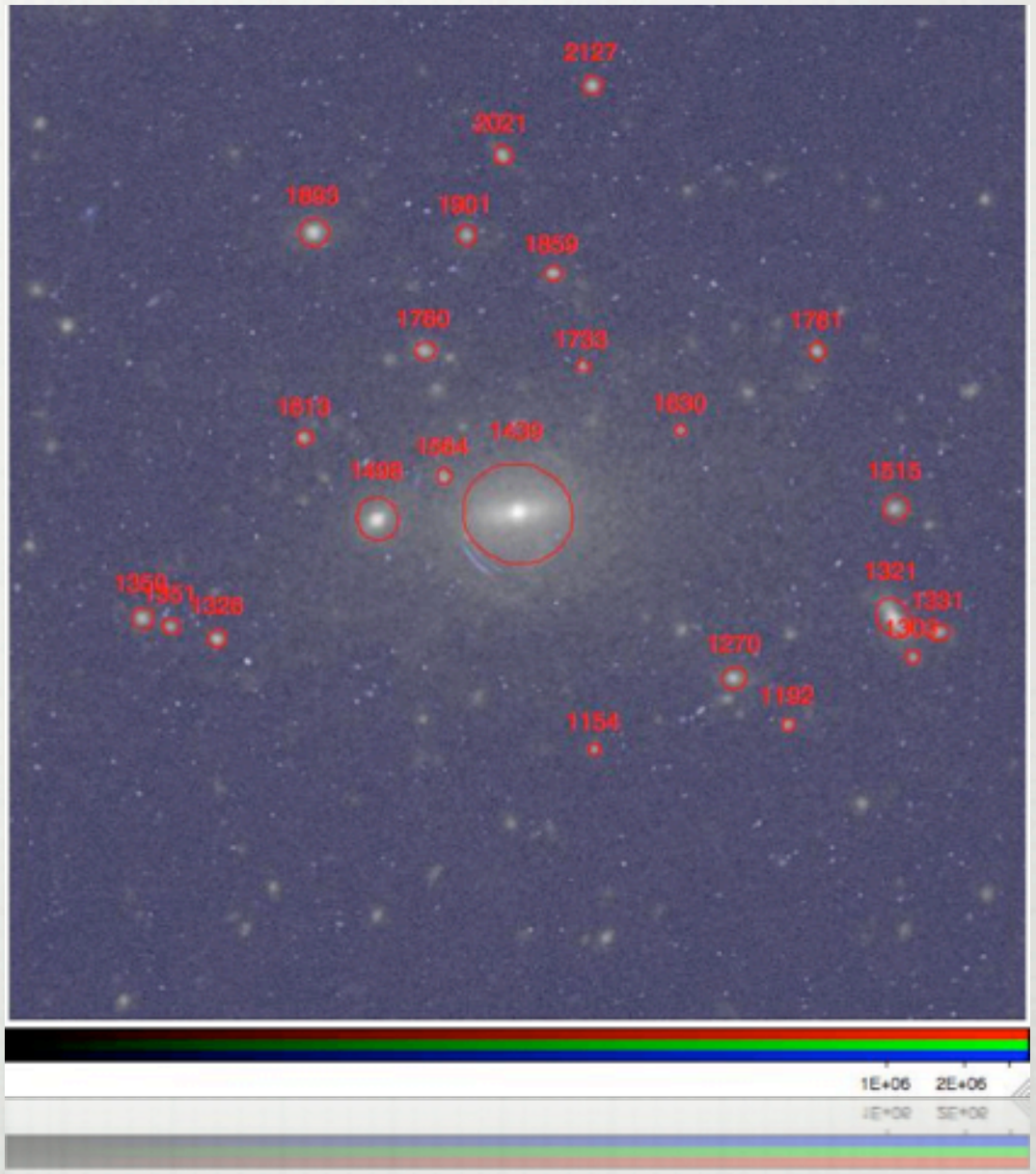

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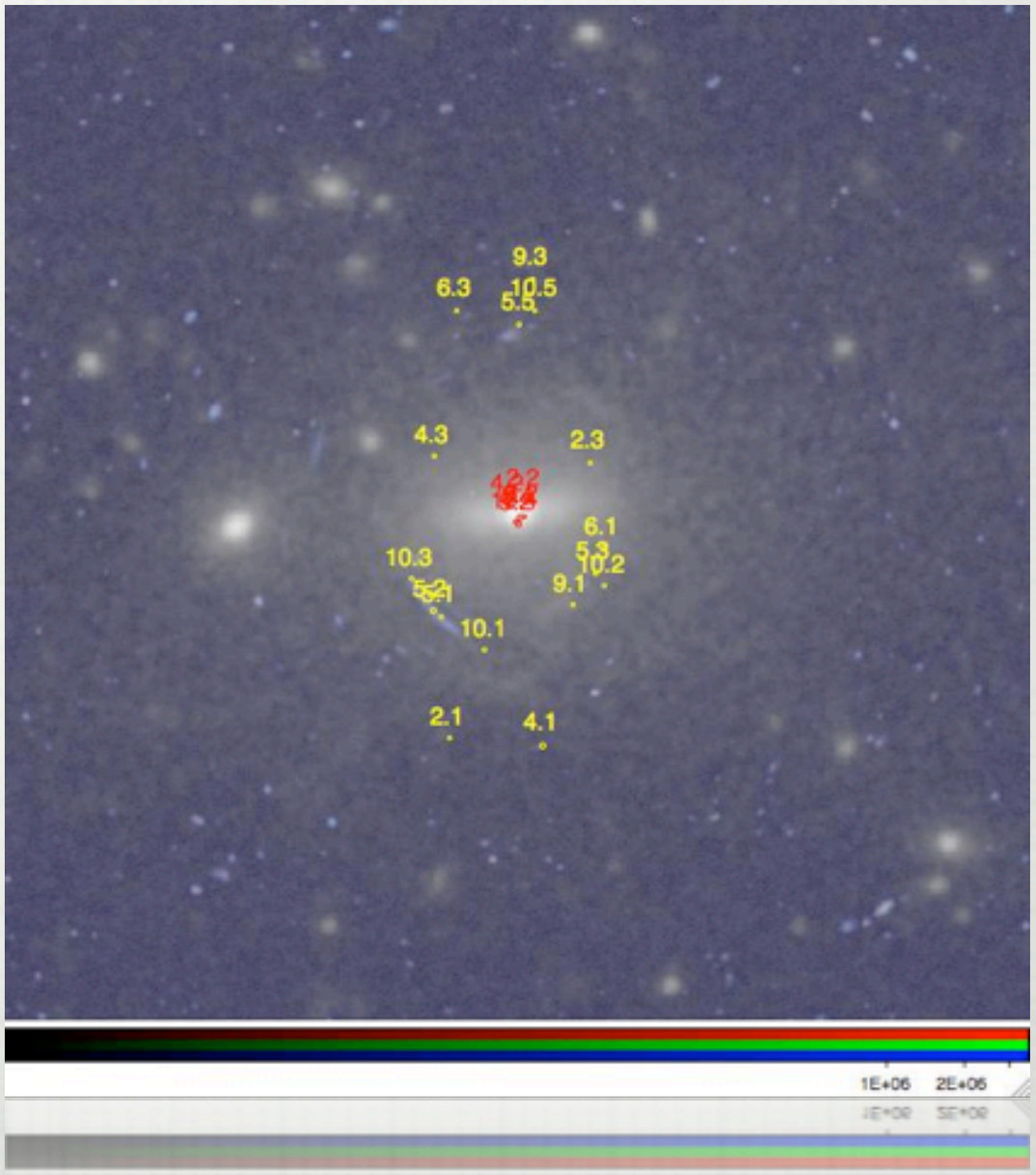

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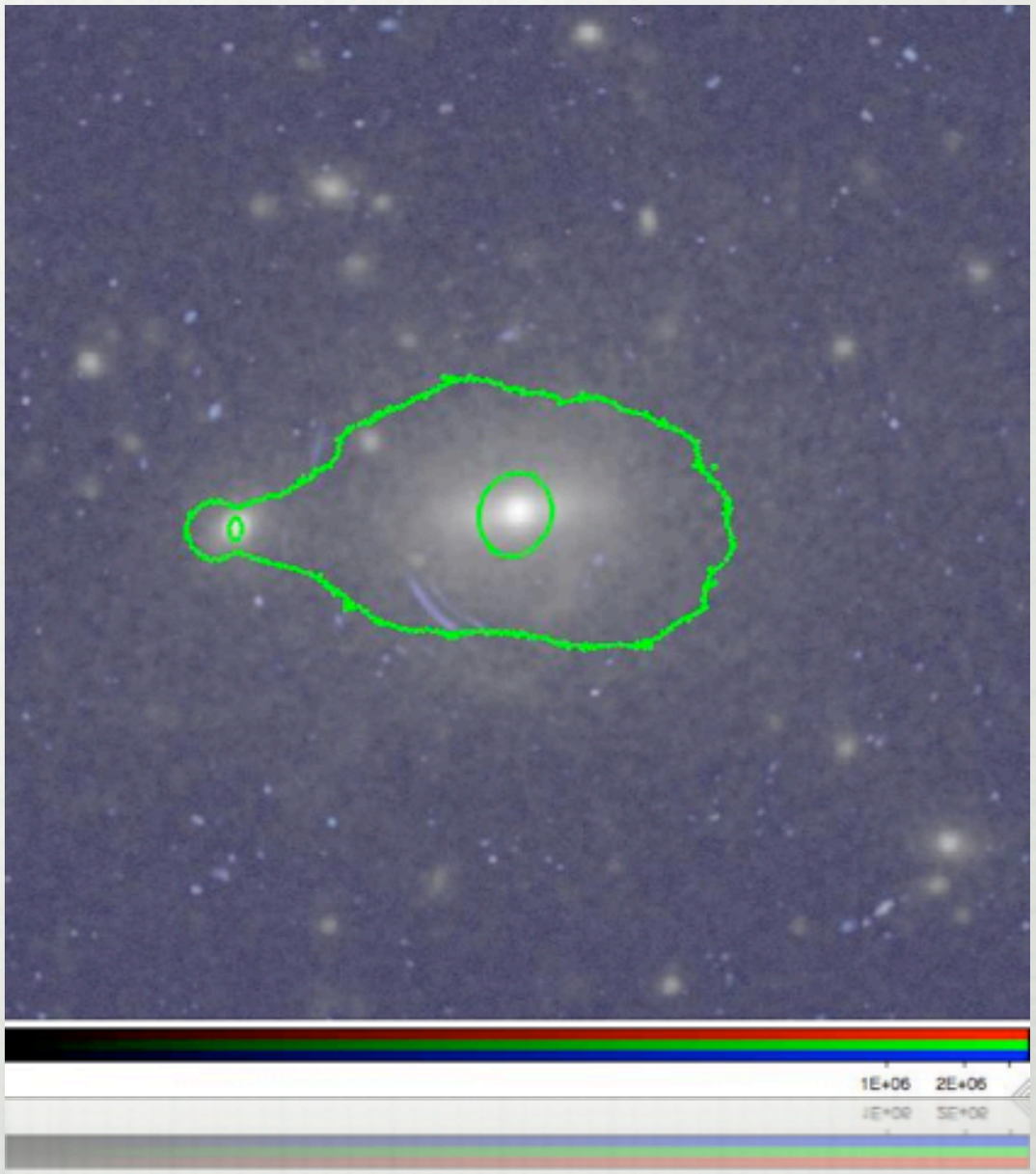

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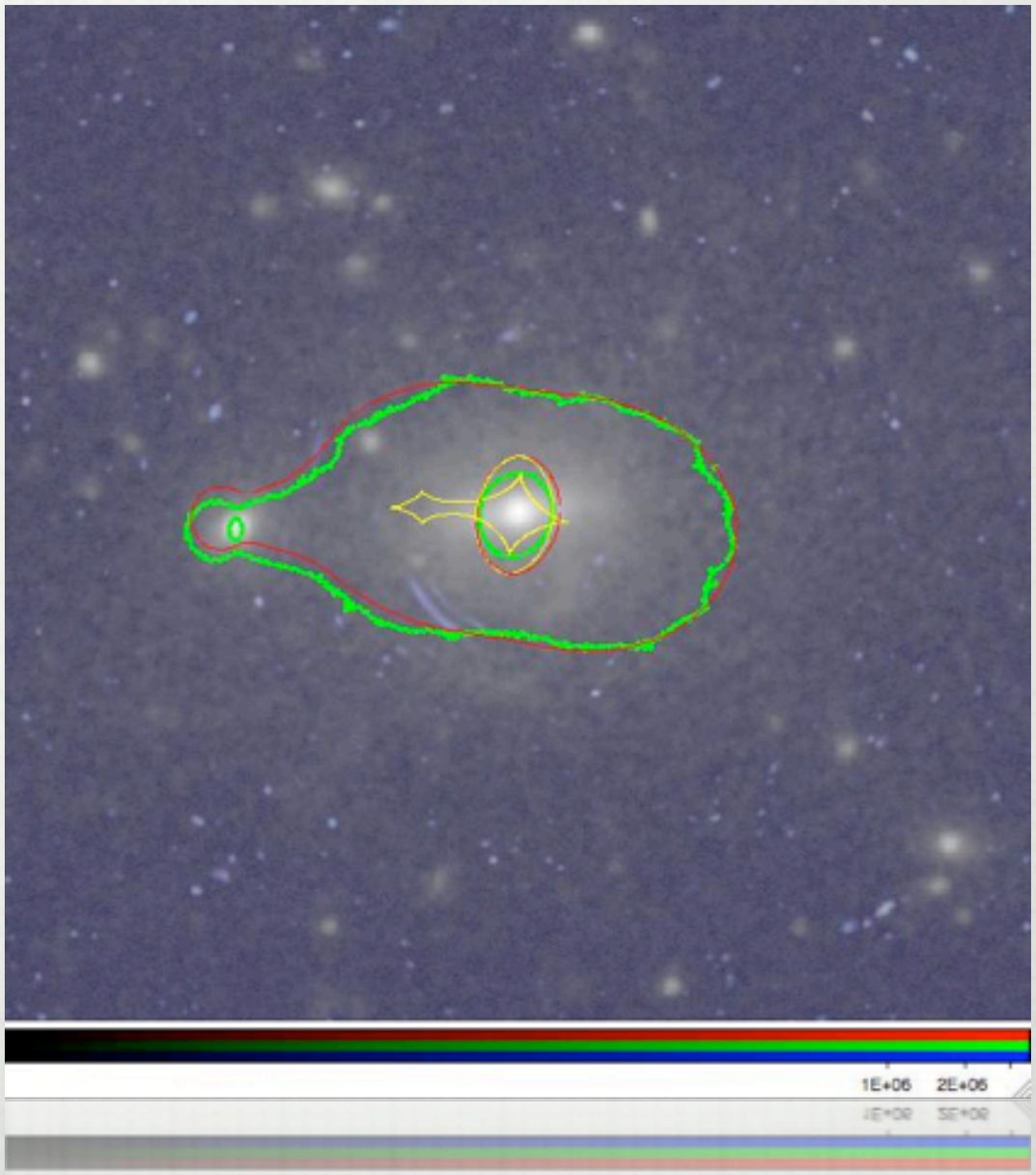

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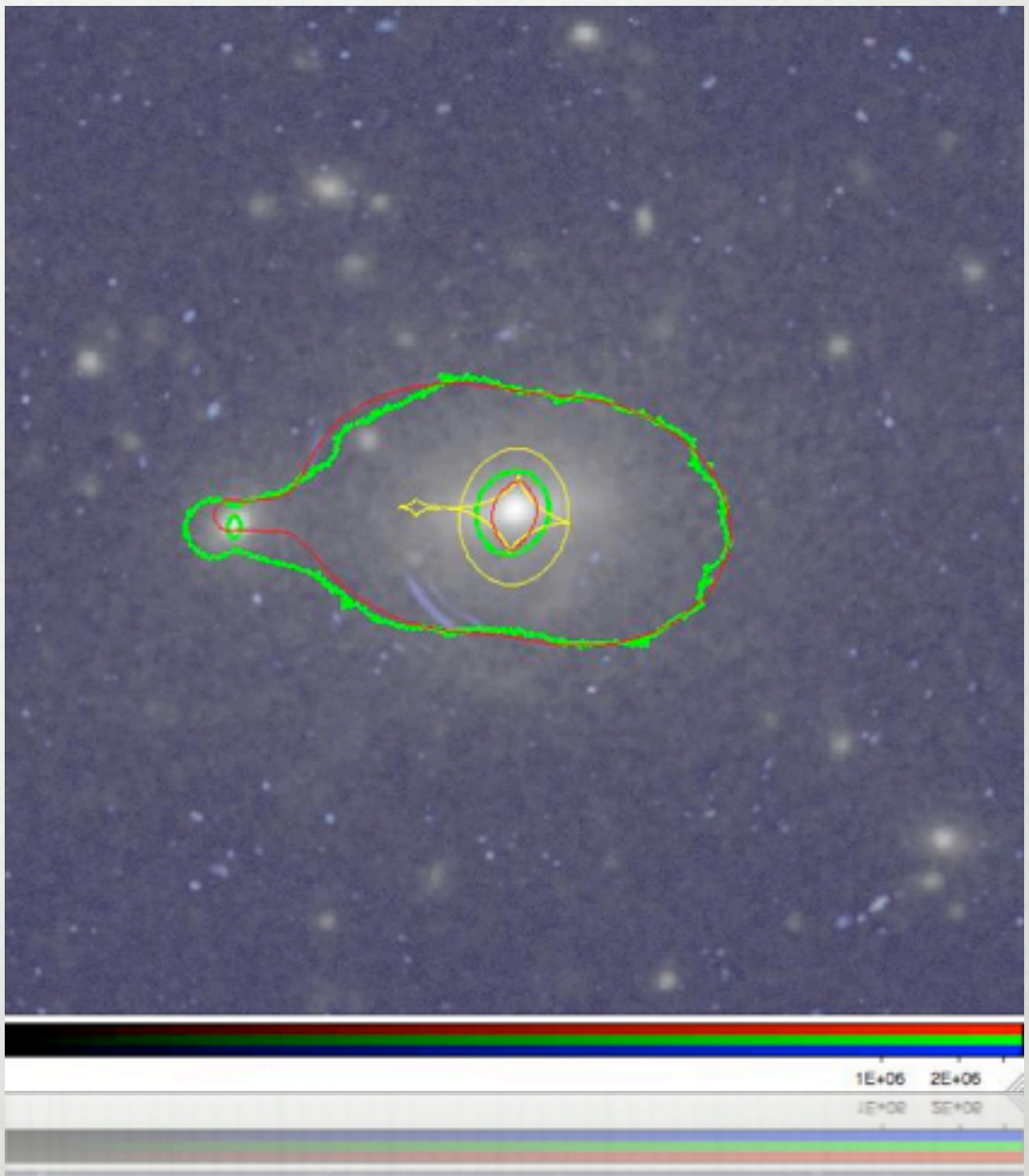

EXAMPLE: X-RAY ANALYSIS

- [ ] XMM OR CHANDRA OBSERVATION
- [ ] MASKING OF SMALL AND COLD BLOBS OF GAS
- [ ] SURFACE BRIGHTNESS PROFILE
- [ ] TEMPERATURE PROFILE BY EXTRACTING SPECTRA IN ANNULI
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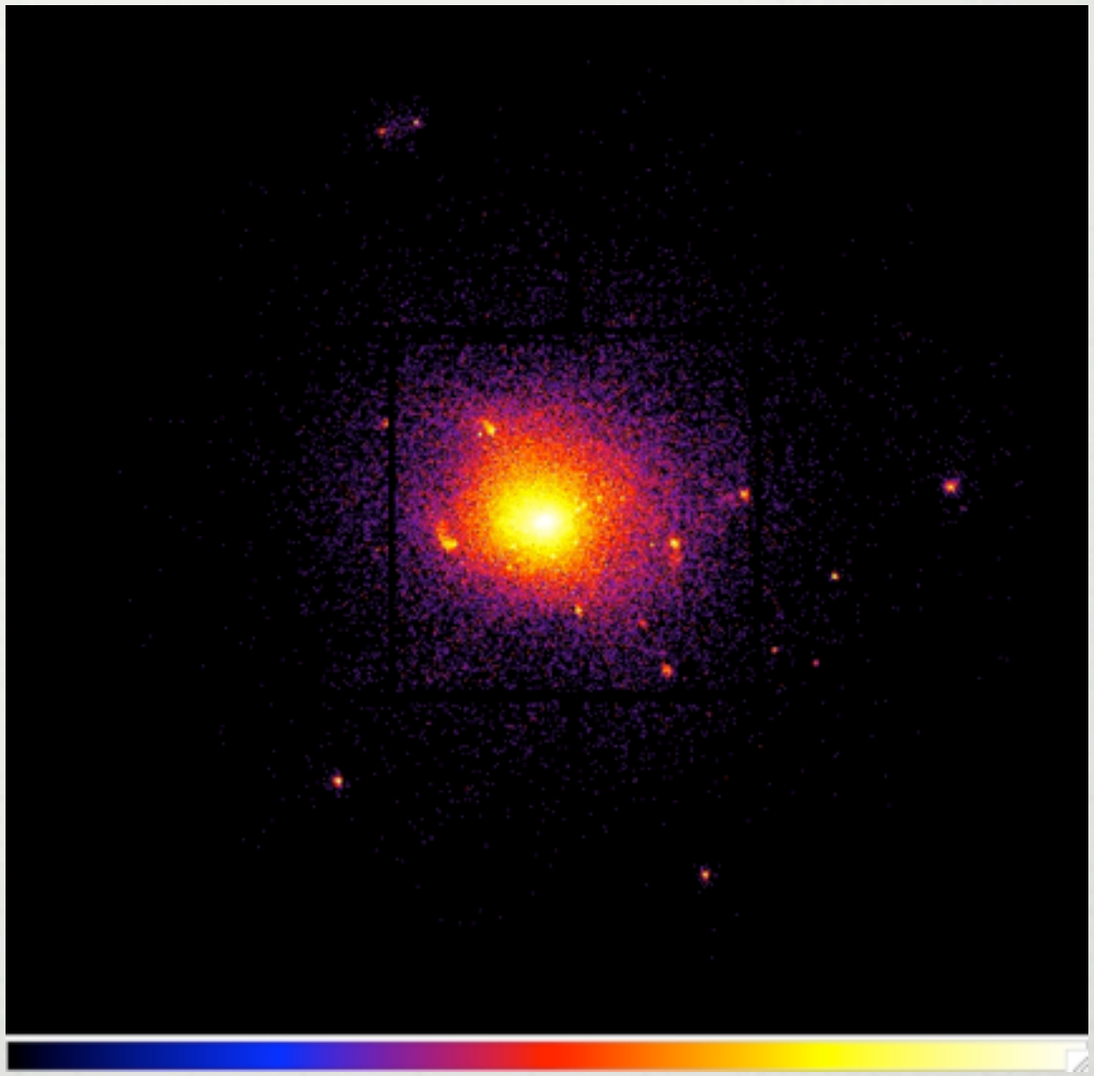

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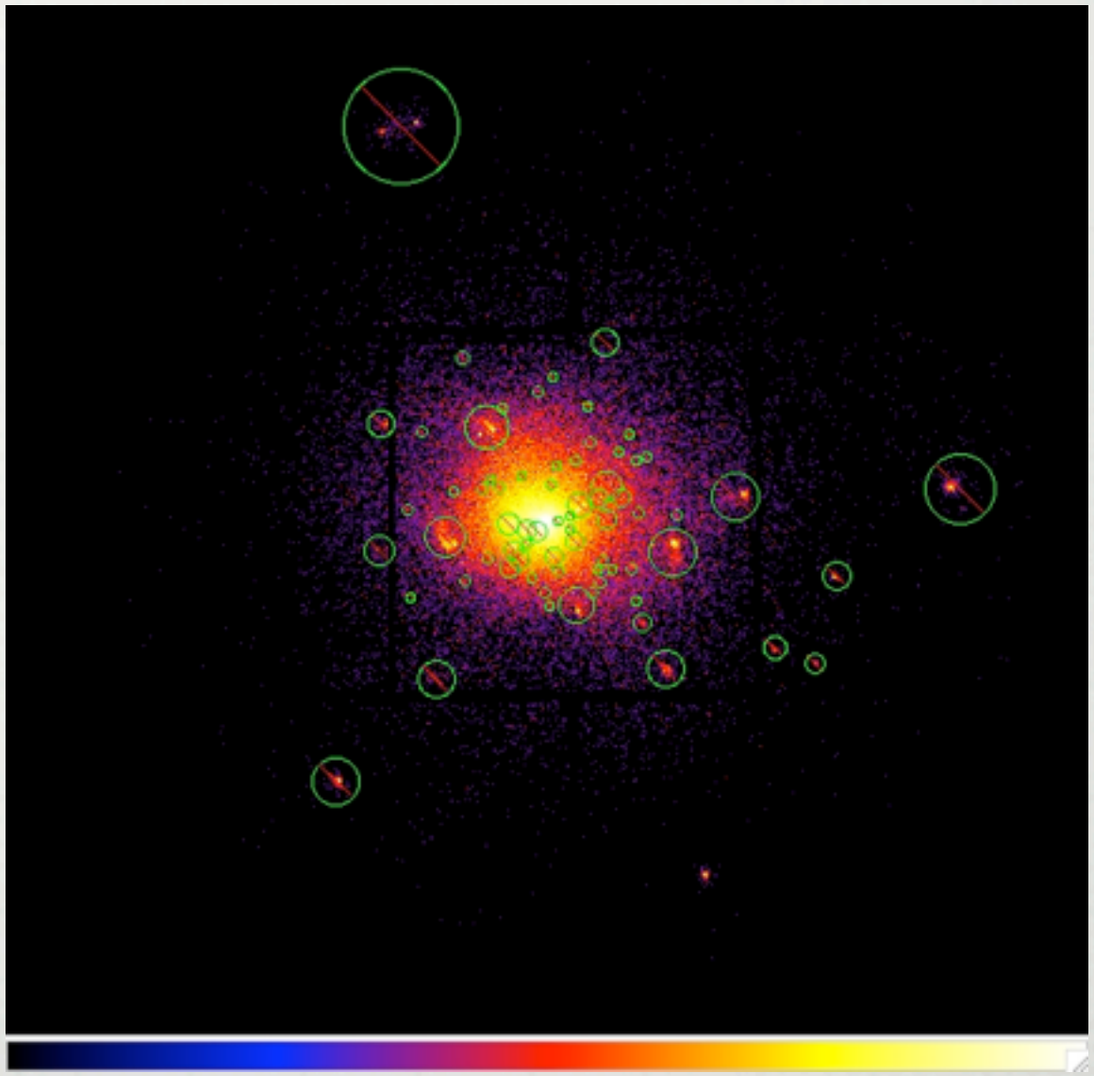

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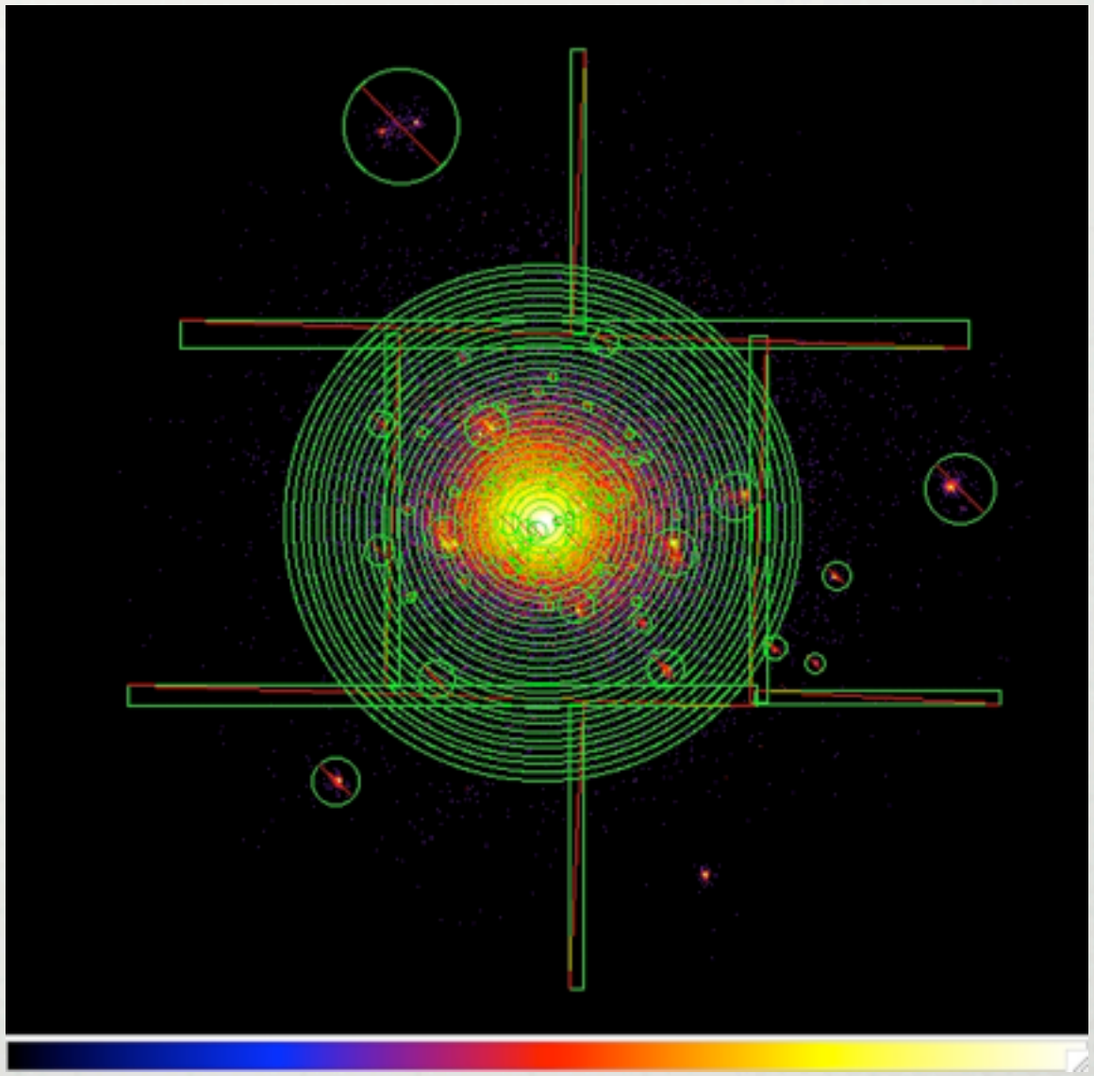

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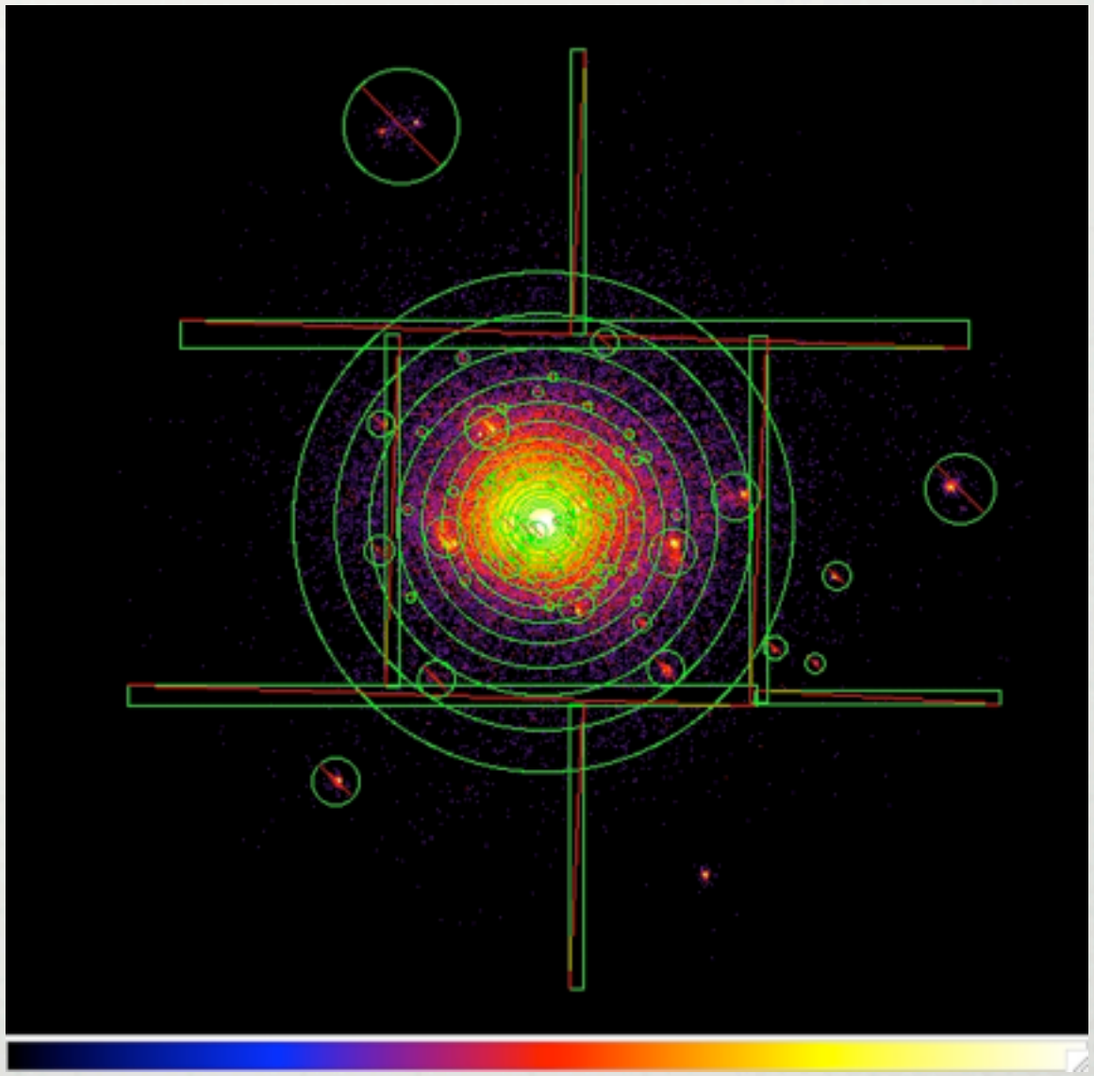
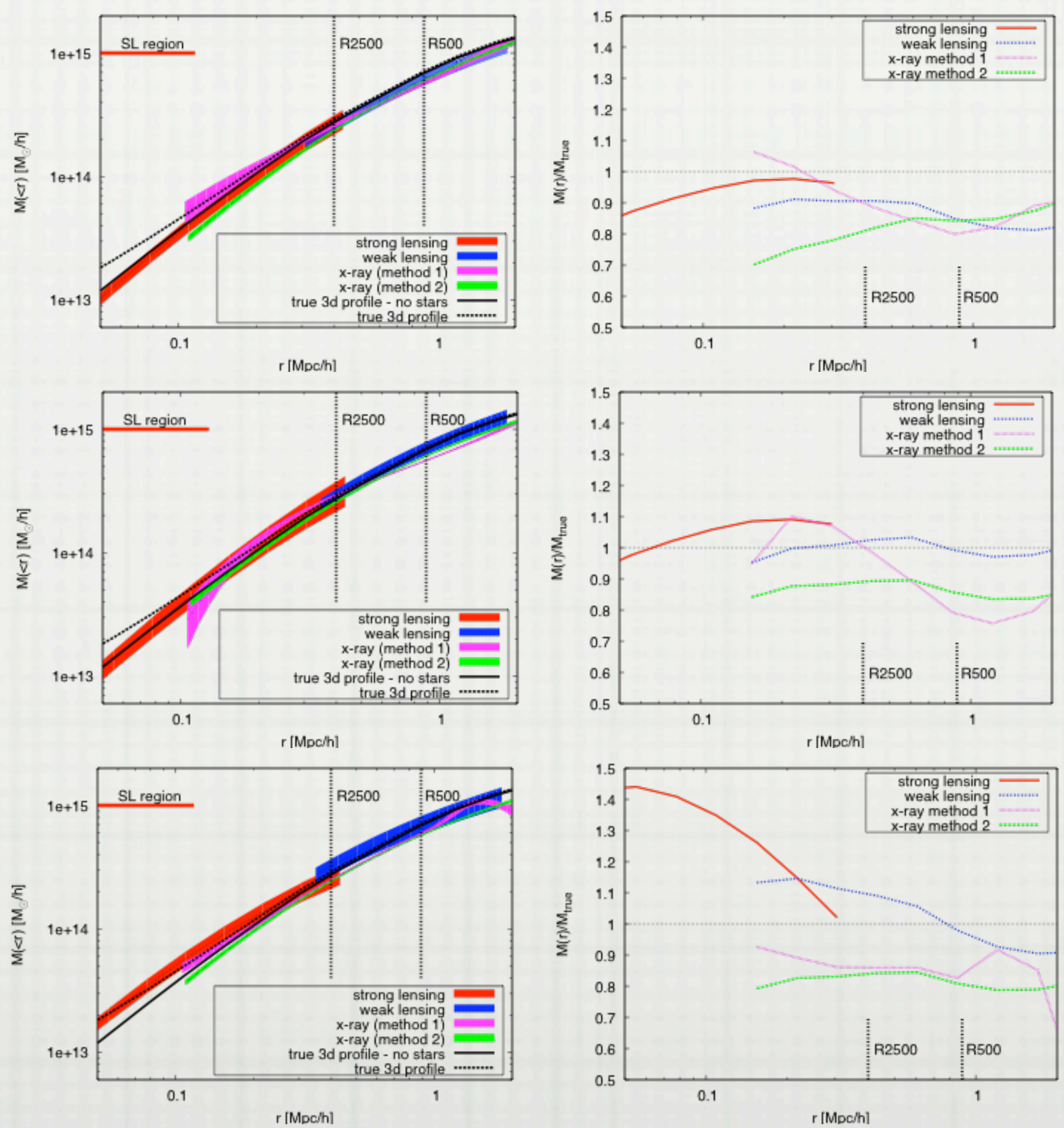


X-RAY VS LENSING



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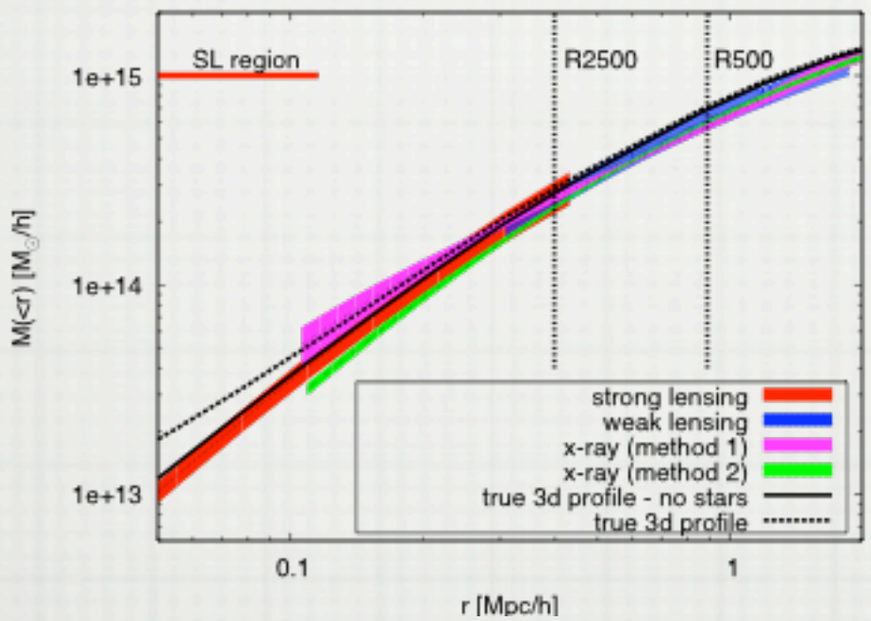

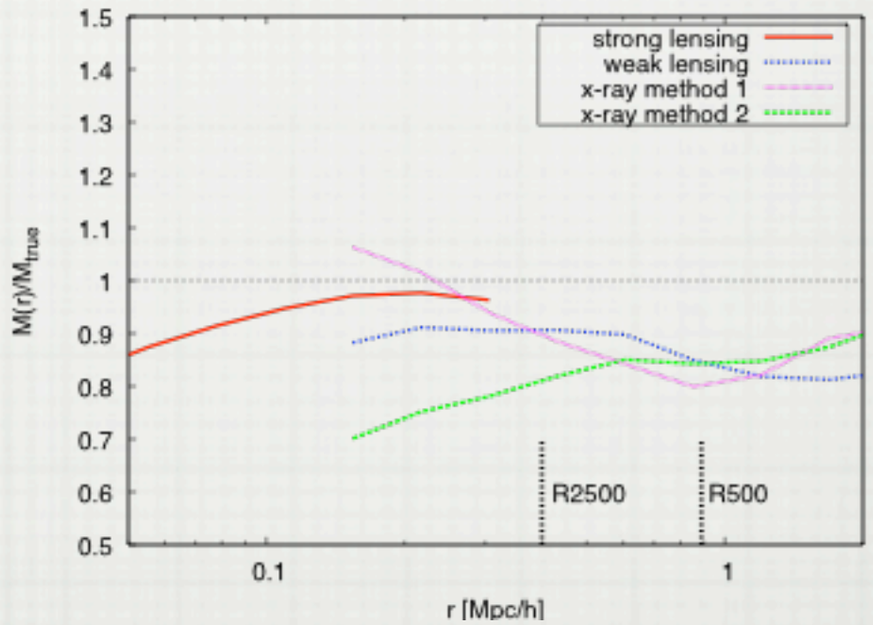

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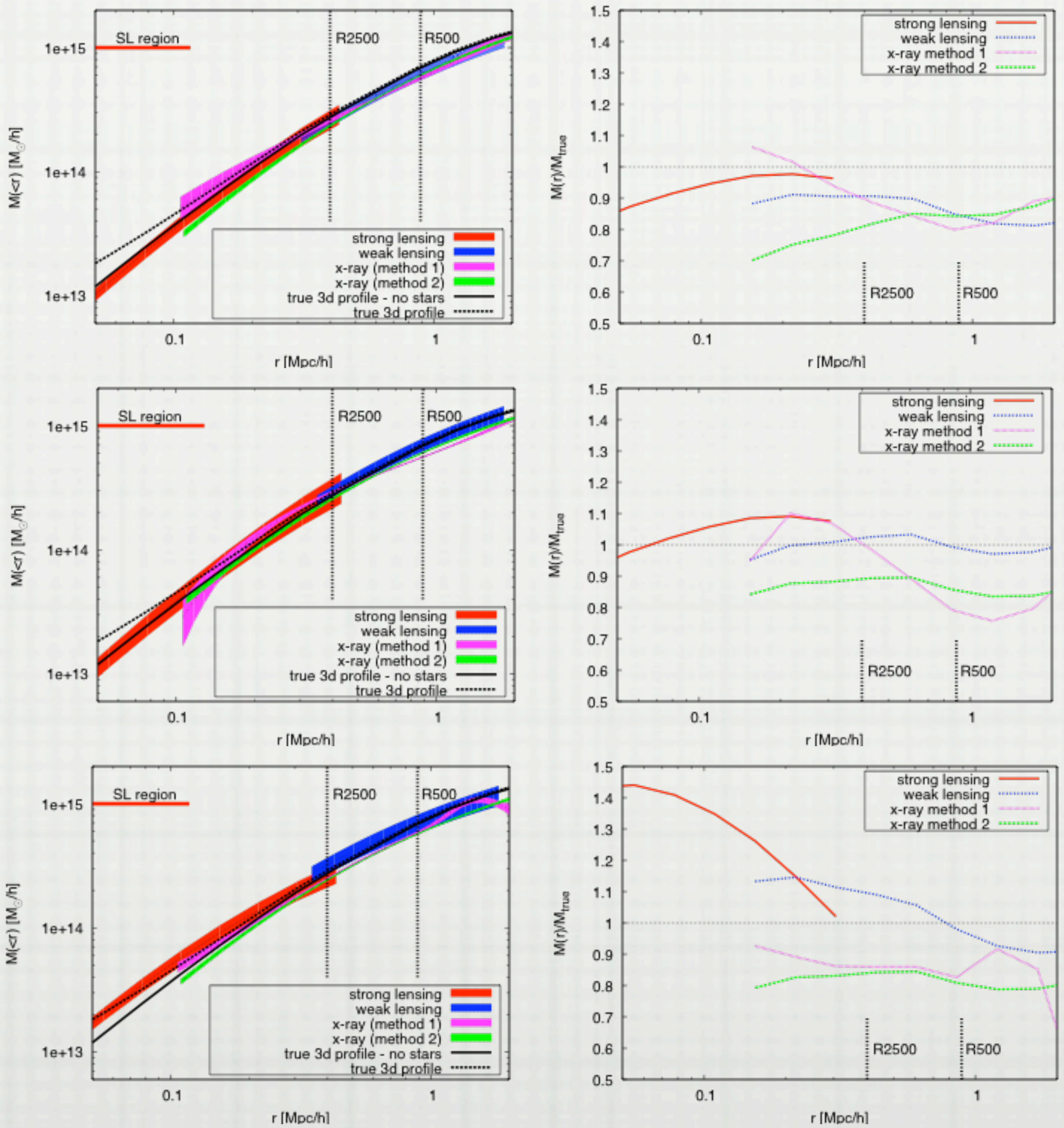

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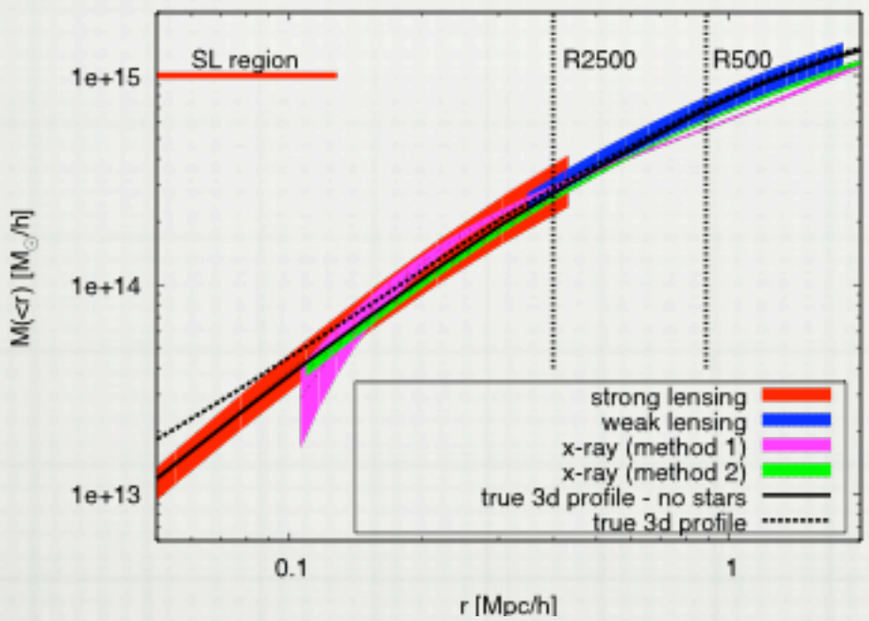

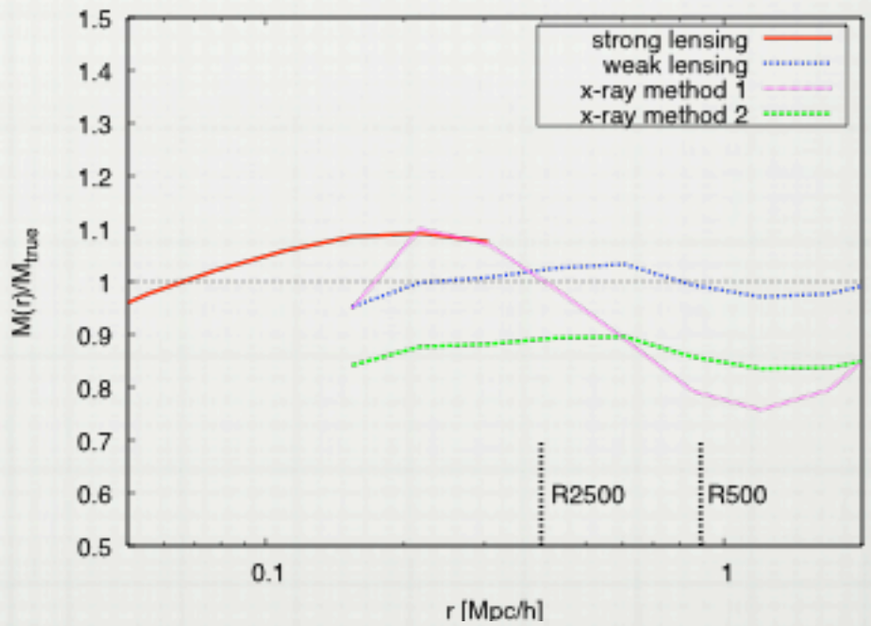

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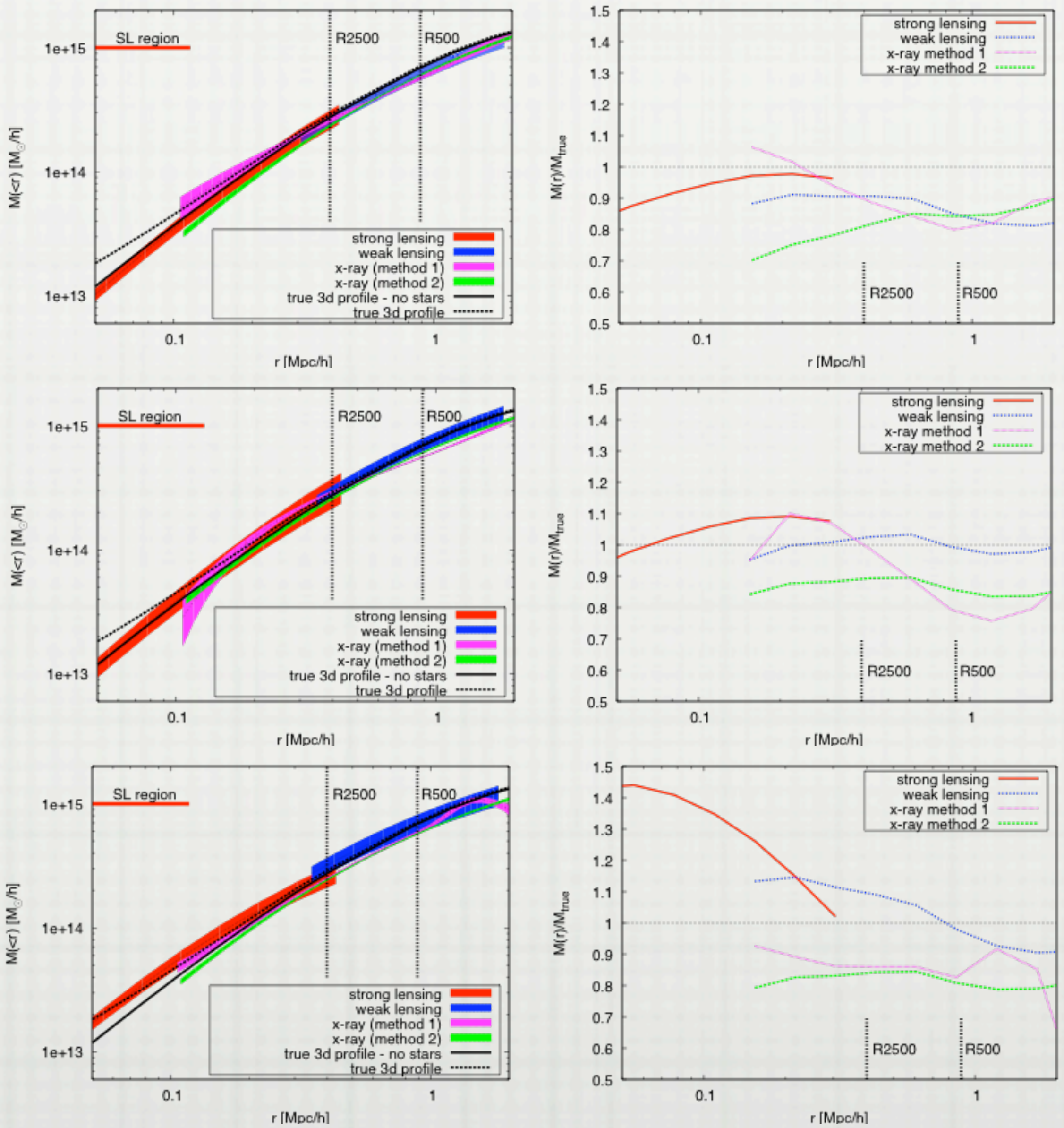

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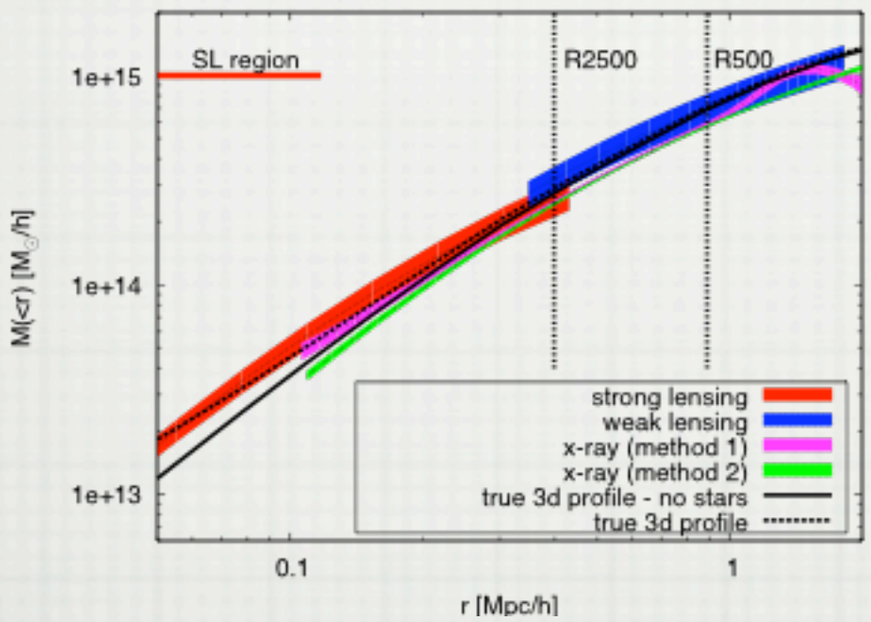

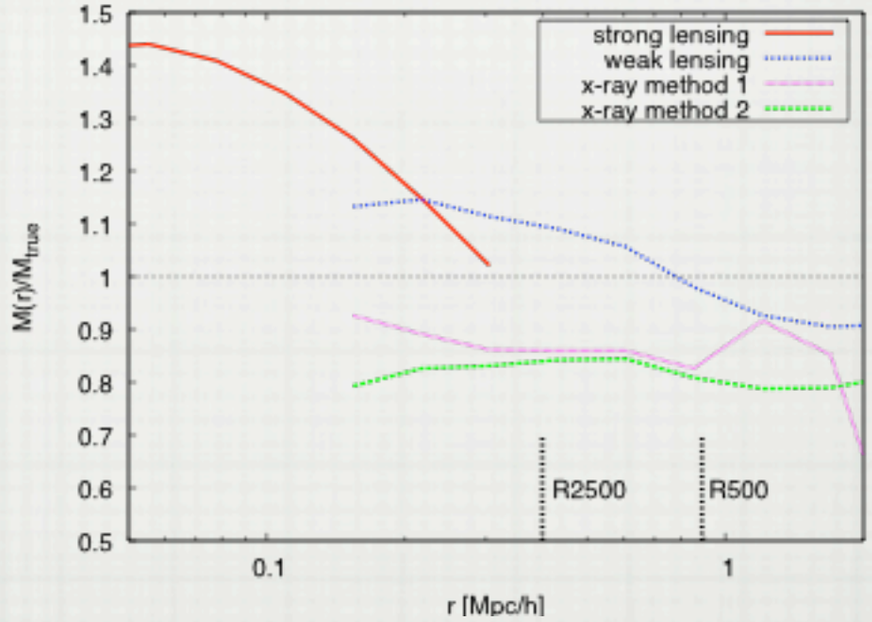

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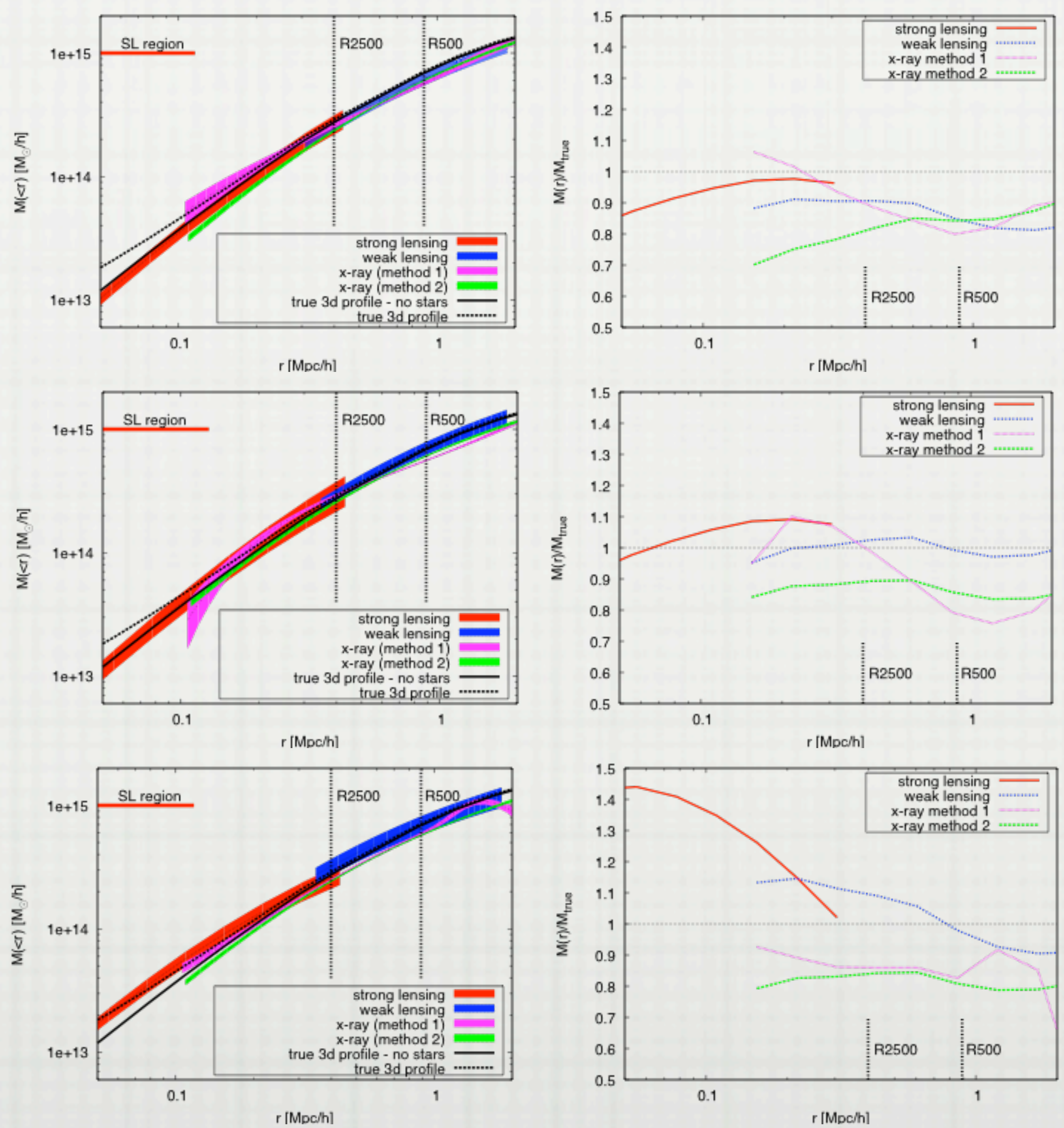

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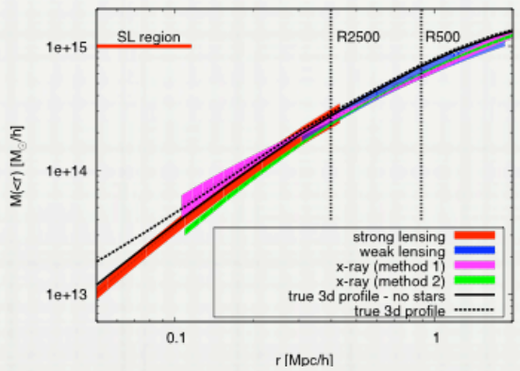

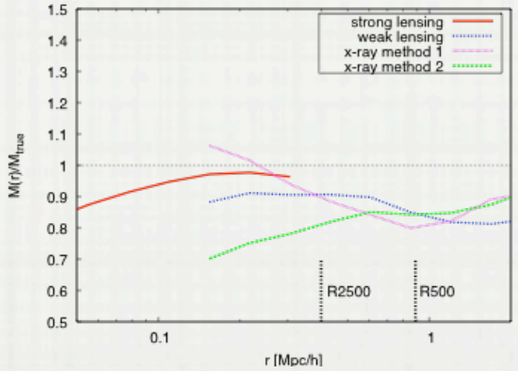

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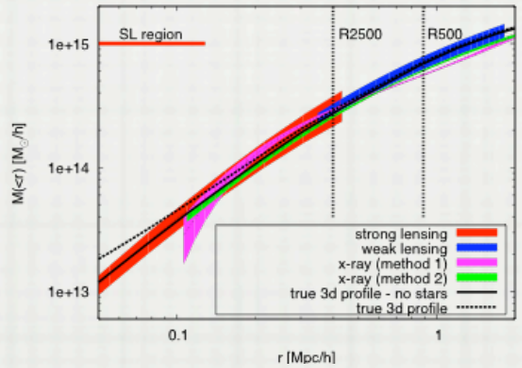

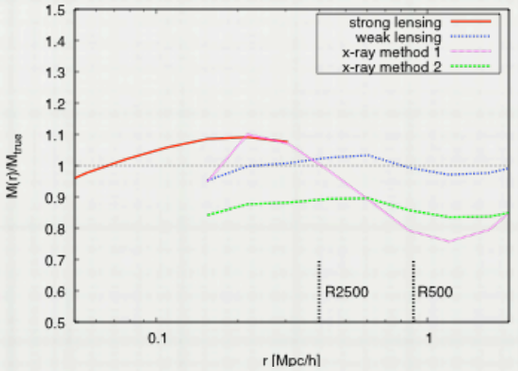

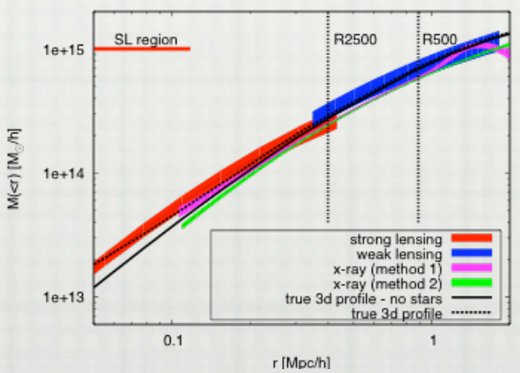

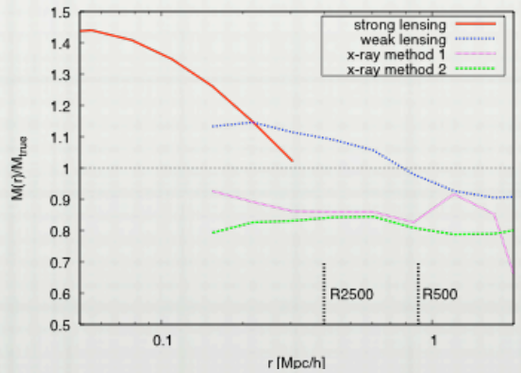

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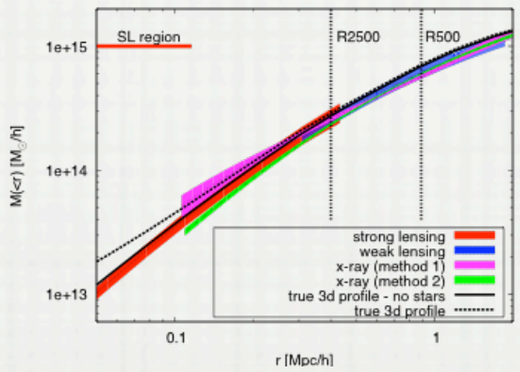

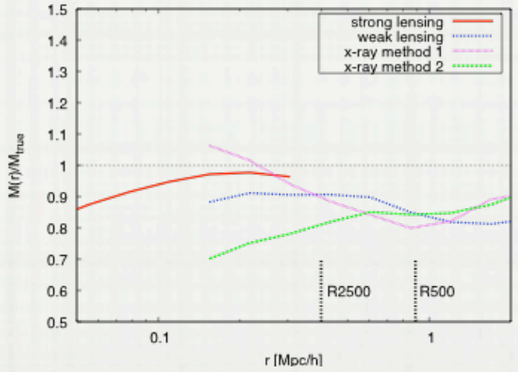

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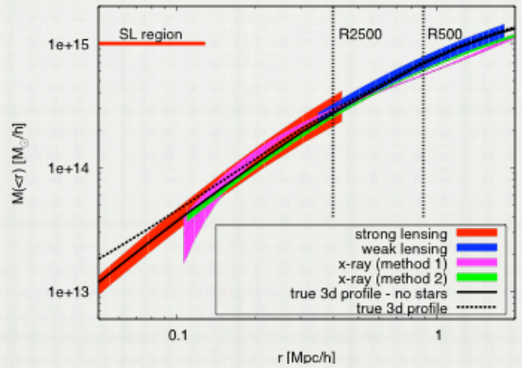
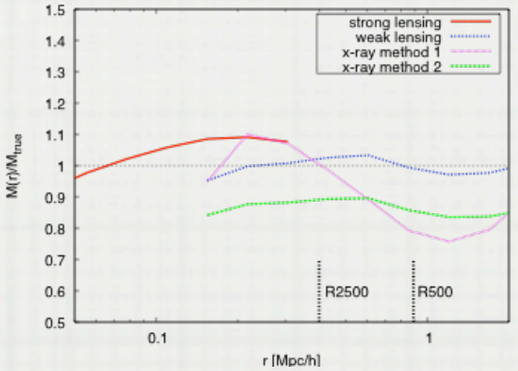
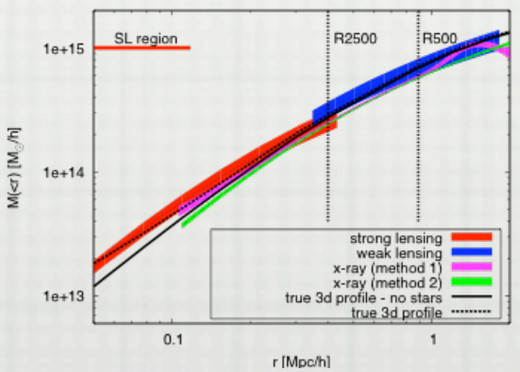
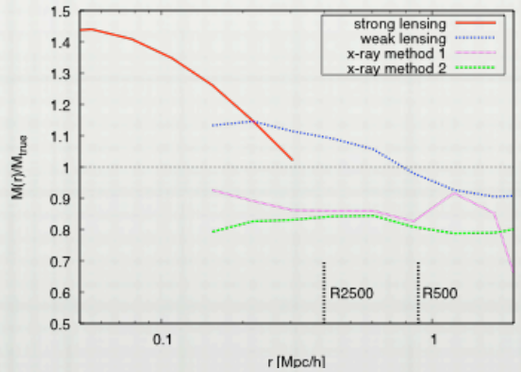


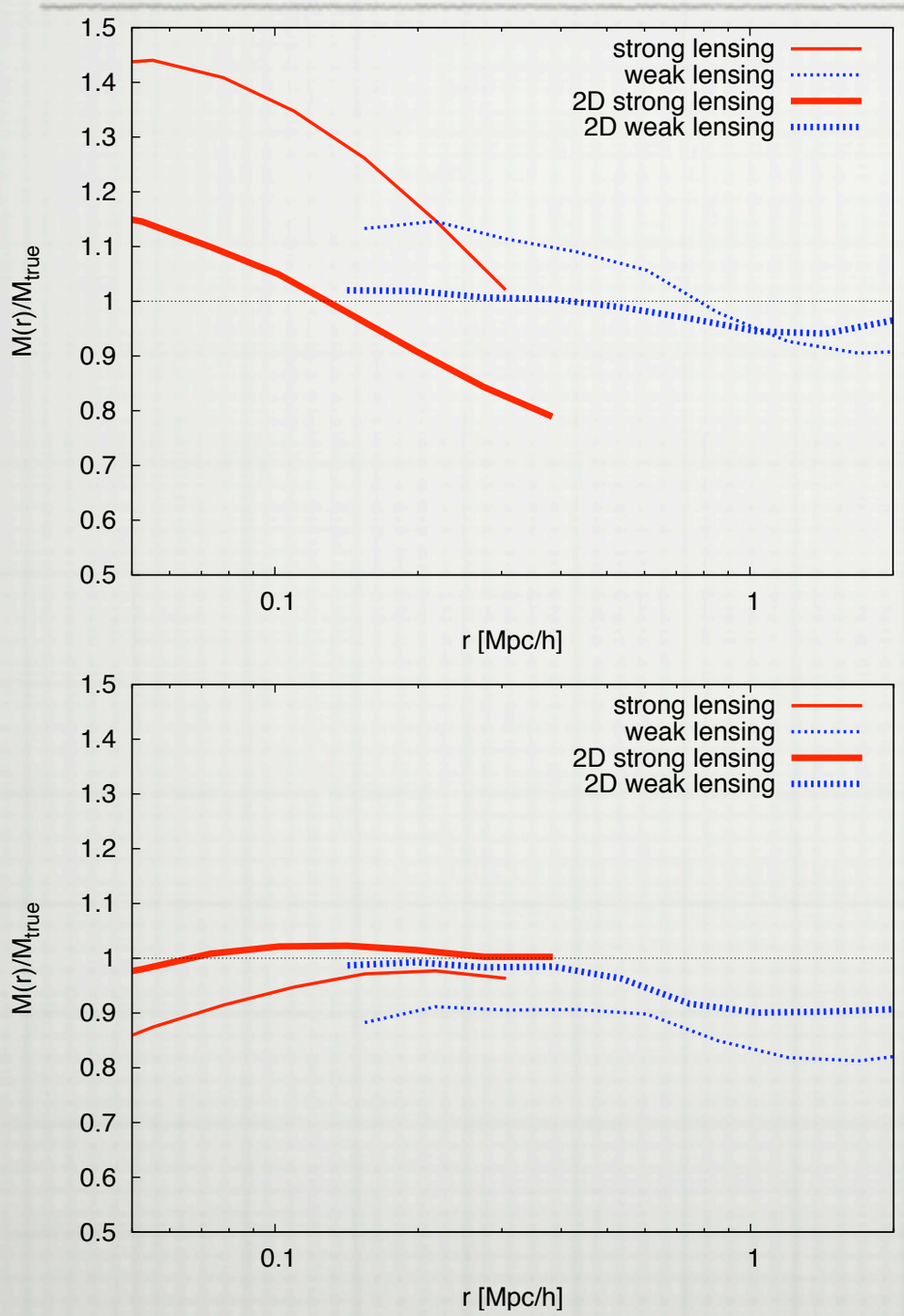


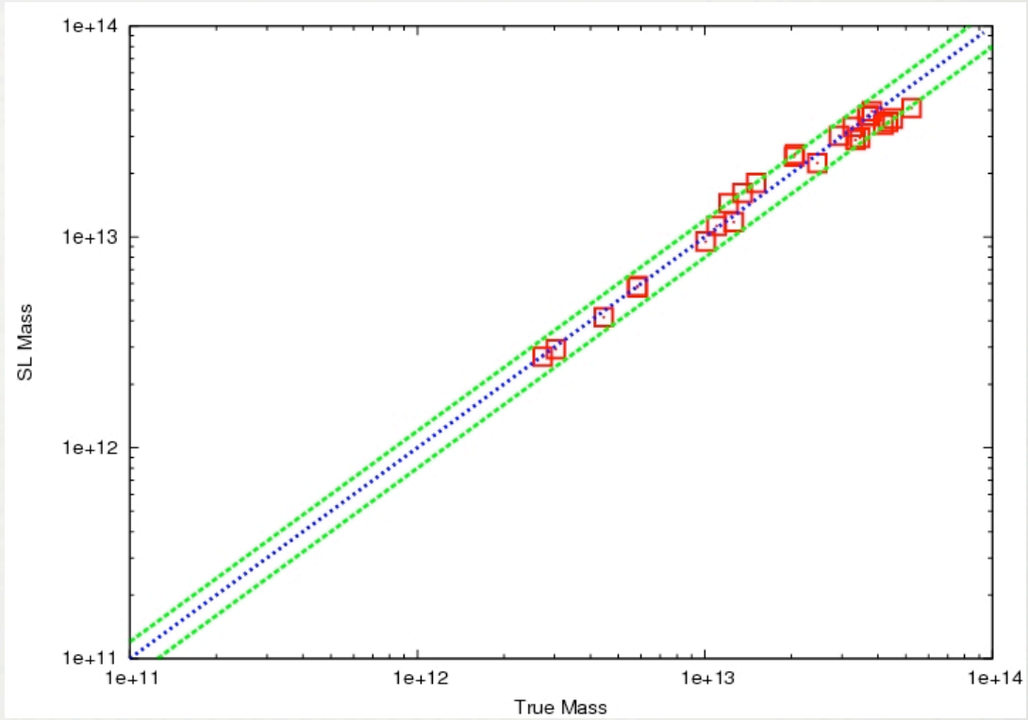




ELONGATED

2D VS 3D LENSING MASS PROFILES





PROJECTION EFFECTS, MORE IMPORTANT AT THE CENTRE

BETTER TO COMPARE PROJECTED MASSES?

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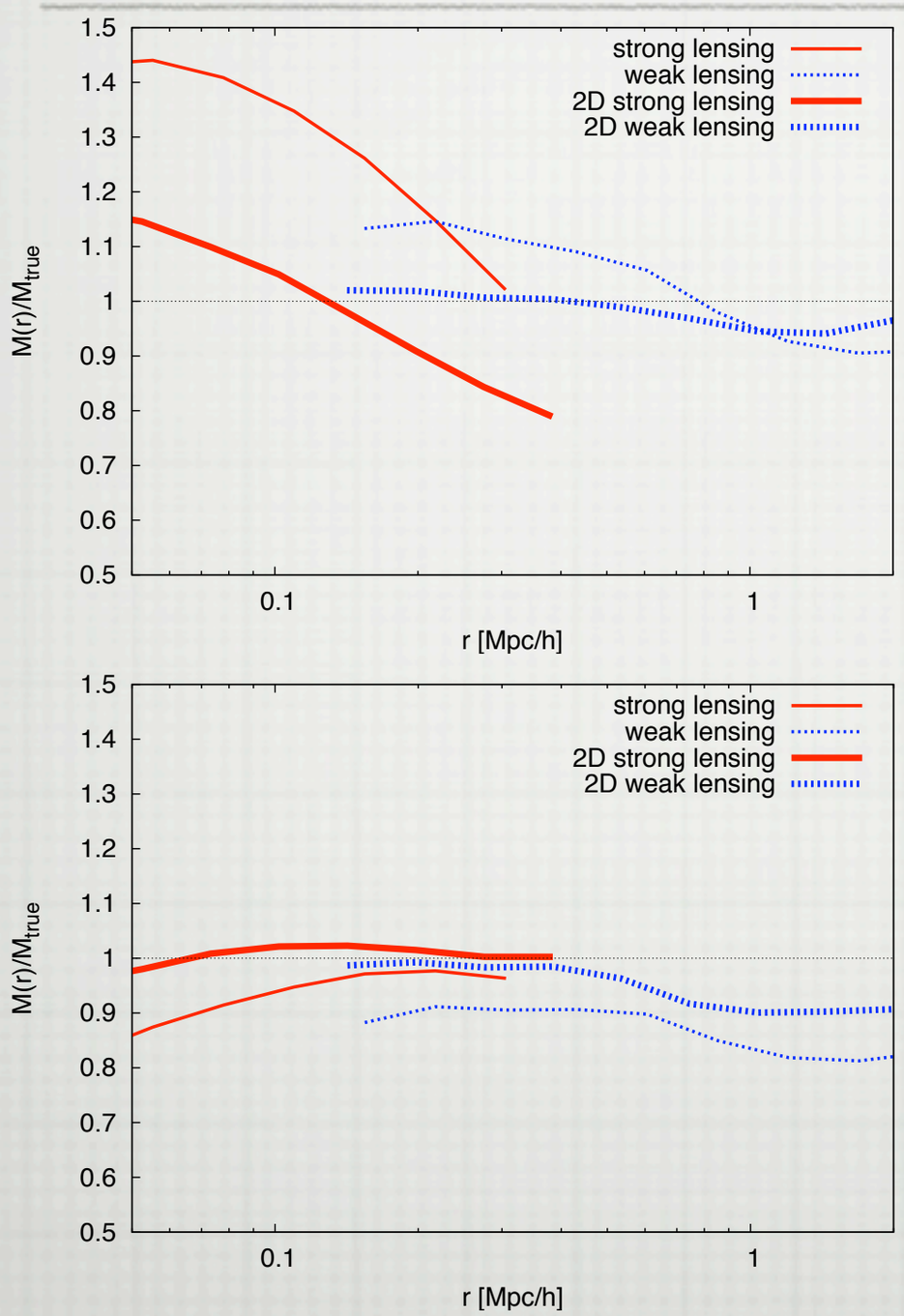

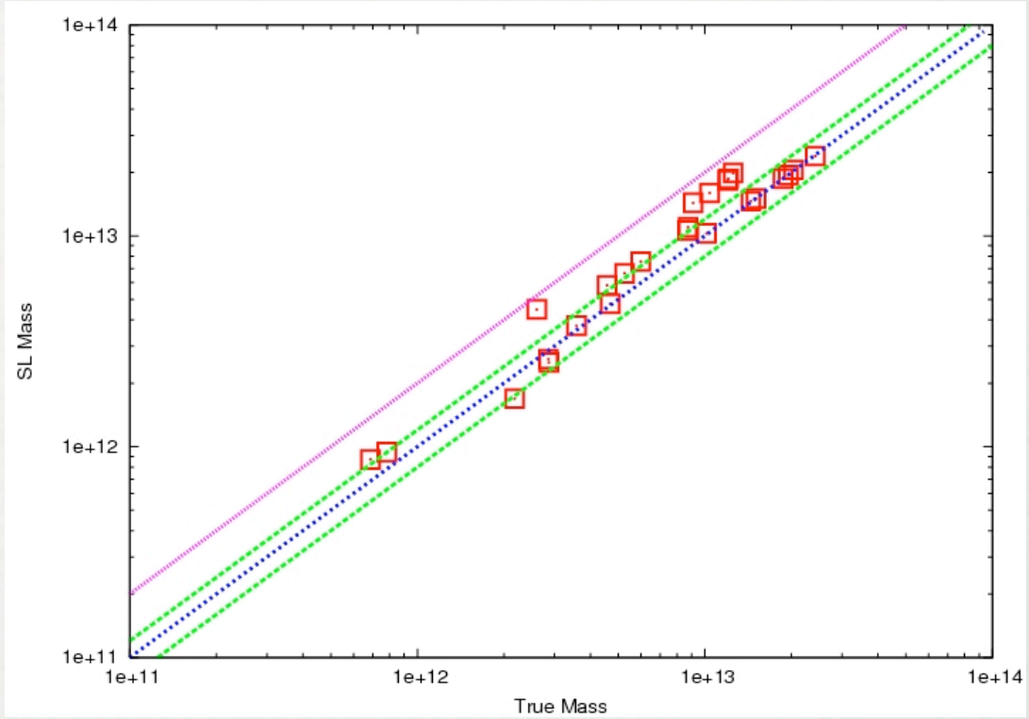

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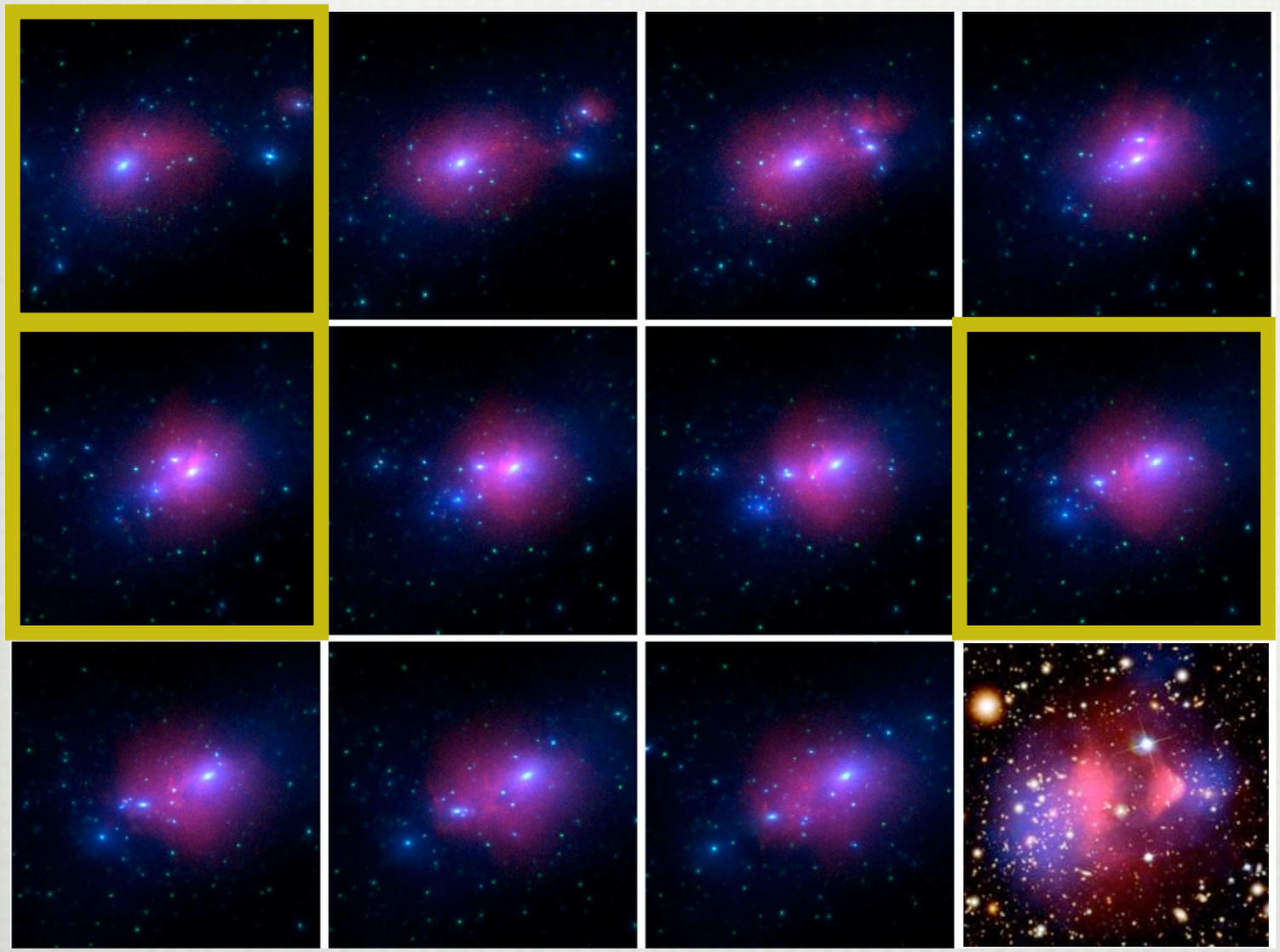
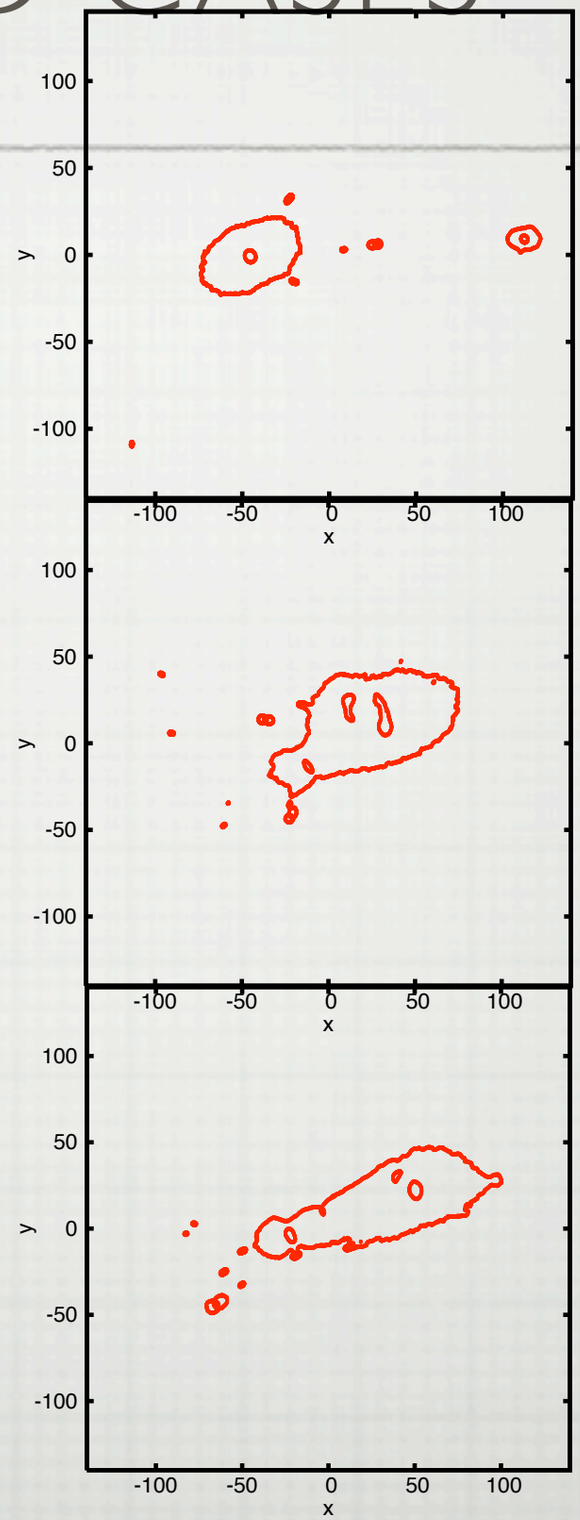
MORE COMPLICATED CASES





CONCLUSIONS

- [ ] X-RAY: TYPICALLY UNDER-ESTIMATE TRUE MASS BY (~15-20%) [SEE ALSO RASIA ET AL. 2006; NAGAI ET AL. 2007]

- [ ] WEAK LENSING: GOOD MASS ESTIMATES (~10%)

- [ ] STRONG LENSING (AND WEAK LENSING): SENSITIVE TO PROJECTION EFFECTS

- [ ] IMPORTANT TO QUANTIFY THESE EFFECTS FOR BEING ABLE TO USE LENSING AND X-RAY MASSES TO STUDY THE PROPERTIES OF THE ICM (BULK MOTION OF GAS, LACK OF HYDRO-STATIC EQUILIBRIUM)